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From Candles to Cabinets: "Familiar Chemistry" in Early Victorian Britain

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"Familiar chemistry" flourished in early Victorian Britain. This set of texts an practices advocated drawing scientific lessons from the habitual activities of daily life, in which the hidden chemical contents of common objects and quotidian processes were revealed. Through sensory interactions in the family environment — enlightening conversation and hands-on explorations — a wide range of phenomena could be introduced to childish bodies and minds. A close reading of texts such as Albert J. Bernays' *Household Chemistry* (1852), alongside a consideration of everyday artefacts, as well as novel specialist objects such as Robert Best Ede's "Youth's Laboratory" (ca. 1837–1845), allows a discussion of this educational style, and an introduction of this new analytic category. In particular, I argue, familiar chemistry succeeded by reworking the popular literary genre of the familiar introduction with an emphasis on embodied interactions with emphatically real things, and gave a central role to the familial domestic context. From candles to cabinets, and beyond, in this article I will demonstrate that familiar chemistry provides a new perspective on scientific education and participation in the nineteenth century.

> "the kitchen is a chemical laboratory"
> Friedrich Accum, *Culinary Chemistry* (1821)[1]

The middle-class Victorian home was furnished with many artefacts thought suitable for guiding an introductory chemical education, from cups of tea to candles and cakes of soap. These common objects were used as the starting-points for introductory exploration: beginners were taught to rethink everyday artefacts and activities as scientific and, then, to engage in new investigative and analytical practices that revealed their particular properties and histories, leading up to the most complex and far-ranging experiments and theories. In this way, anything from

[1] Friedrich Accum, *Culinary Chemistry* (London: R. Ackermann, 1821), iv.

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eating breakfast or taking afternoon tea to washing clothes or fireside reading became opportunities for familial lectures, enlightening conversations, and hands-on interactions. Writers and educators emphasised the home as the most appropriate location for elementary scientific instruction, and advocated sensory experience as the best mode of education, seeking to overcome the paradoxical necessity of teaching action through text. It was through manipulation of household artefacts, these authors argued, that the essentially embodied nature of chemical education could best be embraced and imparted. In this article, I shall draw attention to "familiar chemistry" and to the sensory practices of domestic chemical education. Through a close analysis of several texts and surviving artefacts, I shall demonstrate that foregrounding familiarity and the practices of sensory education can cast new light on the place and practices of early Victorian chemistry, as the kitchen became the chemical laboratory.

Much work has already been completed on elementary scientific instruction in the first half of the nineteenth century, and from scholars such as Michèle Cohen and Greg Myers we now have an excellent understanding of what has been termed the "familiar format": didactic dialogues which were overwhelmingly the most popular introductory literary form of the time.[2] These familial discussions, most famously emblematised by Jane Marcet's influential *Conversations on Chemistry* (first published in 1805, but reprinted and updated over the next fifty years), presented discussions between a tutor and pupils, usually at home, and enlivened by simple experiments or excursions.[3] The students acted as proxy for the reader, and, together, their knowledge of a particular subject was gradually built up, as the successive conversations became a coherent programme of study. Far more widespread as a contemporary book title or subtitle term than "popular," "familiar" and its cognates had a particular significance in the period, and seems to have been a clear pointer to readers of what they could expect to find within its pages: the indicator "familiarly explained," in the subtitle to Marcet's book and elsewhere, denoted a particular type of language, one that would mimic familial discussion. Indeed, John Gardner's 1843 British translation of Justus Liebig's *Familiar Letters on Chemistry* emphasised how that work would fit into this wider literary landscape of familiar introductions to both scientific and other topics; the second series of 1844 articulated its purpose as to "render familiar the philosophical principles and general laws of the science."[4]

[2] For instance, Michèle Cohen, "'Familiar Conversation:' The Role of the 'Familiar Format' in Education in Eighteenth- and Nineteenth-Century England," in *Educating the Child in Enlightenment Britain: Beliefs, Cultures, Practices*, ed. Mary Hilton and Jill Shefrin (Farnham: Ashgate, 2009), 99–116; Greg Myers, "Science for Women and Children: the Dialogue of Popular Science in the Nineteenth Century," in *Nature Transfigured: Science and Literature, 1700–1900*, ed. John Christie and Sally Shuttleworth (Manchester: Manchester University Press, 1989), 171–200; and Greg Myers, "Fictionality, Demonstration, and a Forum for Popular Science: Jane Marcet's Conversations on Chemistry", in *Natural Eloquence: Women Reinscribe Science*, ed. Barbara T. Gates and Ann B. Shteir (Madison: University of Wisconsin Press, 1997), 43–60.

[3] Jane Marcet, *Conversations on Chemistry; in which the Elements of that Science are Familiarly Explained and Illustrated by Experiments* 16th ed. (London: Longman, Brown, Green and Longman, 1853).

[4] Justus Liebig, in Preface, *Familiar Letters on Chemistry*, ed. John Gardner (London: Taylor and Walton, 1844 Second Series), 1.

In this article I shall advocate a distinctive educational category — "familiar chemistry" — which goes beyond appreciating elementary instruction as a conversational literary genre, and, rather, conceives of it as a practical didactic style, employing emphatically real objects and domestic activities. "Familiar chemistry", then, can join the "familiar format" as an analytical designator specific to works and practices of the late eighteenth to mid-nineteenth centuries. When combined with existing scholarship on early chemical cabinets, such as that by Brian Gee, it can also demonstrate how these experiments fitted into existing household practices.[5] Scientific knowledge was not only taken *to* the middle-class home in these years, but was revealed to be *of* the middle-class home as well. "Familiar chemistry" was therefore deeply indebted to the mode of instruction elaborating the hidden histories and properties of everyday artefacts that was commonplace in Victorian domestic education and beyond. These object lessons drew on influential pedagogic philosophies of sensory learning, and on the global interconnectedness of science, industry and empire.[6] Working outwards from particular bounded familiar things — a piece of chalk, a pebble — and relying on the senses as the "five gateways of knowledge," such lessons destabilised and enriched the quotidian world, demonstrating the profound subjects that could be introduced from an ostensibly simple starting-point.[7] The "narrative format of common things," in Bernard Lightman's phrase, was an appealing choice for introductory books and lectures, making scientific subjects child-sized and unthreatening, and was readily combined with other popular narrative approaches such as biography, the "familiar format" of didactic dialogues itself, or the catechism, also used by Samuel Parkes for introducing chemistry.[8] Some argued that the use of common things and sensory education was particularly appropriate for both children and the working-classes, and the approach gained popularity throughout the century, entering school syllabuses and leading to the production

[5] See Brian Gee, "Amusement Chests and Portable Laboratories: Practical Alternatives to the Regular Laboratory," in *The Development of the Laboratory: Essays on the Place of Experiment in Industrial Civilisation*, ed. Frank A. J. L. James (Basingstoke: Macmillan Press, 1989), 37–59; David Knight, "Pictures, Diagrams and Symbols: Visual Language in Nineteenth-Century Chemistry," in *Non-Verbal Communication in Science Prior to 1900*, ed. Reanto G. Mazzolini (Firenze: Leo S. Olschki, 1993), 321–34; and Rosie Cook, "Chemistry at Play," *Chemical Heritage Magazine* 28, no 1 (Spring 2010). http://chemheritage.org/discover/media/magazine/articles/28-1-chemistry-at-play.aspx?page=1 (accessed 15/6/12). For twentieth-century chemistry sets, see Salim Al-Gailani, "Magic, Science and Masculinity: Marketing Toy Chemistry Sets," *Studies in History and Philosophy of Science* 40 (2009): 372–81.

[6] See Melanie Keene, *Object Lessons: Sensory Science Education, 1830–1870* (unpublished PhD dissertation, University of Cambridge, 2008). For an introduction to the later use of object lessons in the United States, see Sarah Anne Carter, "On an Object Lesson, or Don't Eat the Evidence," *The Journal of the History of Childhood and Youth* 3 (2010): 7–12.

[7] For instance, Thomas Henry Huxley's 1868 lecture "On a Piece of Chalk," reprinted in *The Major Prose of Thomas Henry Huxley*, ed. Alan P. Barr (Athens: University of Georgia Press, 1997), 154–73; Gideon Algernon Mantell's 1836 children's book *Thoughts on a Pebble* (London: Reeve, Benham and Reeve, 1836). See Melanie Keene, "'An Object in Every Walk:' Gideon Mantell and the Art of Seeing Pebbles," in *Objects of Natural History: Cabinet of Natural History Books, IV*, eds. Helen Macdonald and Francis Reid (Cambridge: Department of History and Philosophy of Science, 2008), 29–39. For a contemporary elaboration of the senses as the "living inlets of learning," see George Wilson, *The Five Gateways of Knowledge* (Cambridge: Macmillian, 1856), 2.

[8] Bernard Lightman, *Victorian Popularizers of Science: Designing Nature for New Audiences* (Chicago: University of Chicago Press, 2007), 129.

of dedicated "object lesson" cards in Britain and America.[9] It formed part of a more general contemporary adoption of "familiar science" that I have identified as a key contemporary educational strategy that built new knowledge on old.[10]

A re-reading of Marcet's *Conversations on Chemistry* reveals that, alongside the more specialist experimental set-ups literally illustrated in the book, figurative illustrations and sensory experiences drawn from everyday life were constantly employed as familiar explanatory tools.[11] For instance, in a discussion of "caloric," "Mrs. B." moved outwards from the "experiments" she had been discussing to use an everyday example that would have been known to her female students: that "light-coloured dresses, in cold weather, should keep us warmer than black clothes". She also followed up this observation — common knowledge that it was assumed her students would already own — with new vocabulary of its scientific underpinnings: that "the latter radiate so much more than the former."[12] The domestic setting in which the lesson was taking place was converted into a hands-on demonstration of the different conductive qualities of varied household materials, as "Mrs. B." instructed her students to "lay [their] hands[s] successively on every object in the room," to "discover which are good and which are bad conductors of heat." They would be able to "discover" these scientific properties through sensory comparison and embodied knowledge, "by the different degrees of cold you feel," as their hands were converted into scientific instruments.[13] This new knowledge was then built up with further hypothetical question-and-answer between teacher and pupil, again relying on familiar examples, and on the correction of erroneous reflections:

> Mrs. B.: … Now, can you tell me why flannel clothing, which is a very bad conductor, prevents our feeling cold?
>
> Caroline: It prevents the cold from penetrating –
>
> Mrs. B.: But you forget that cold is only a negative quality.
>
> Caroline: True; it only prevents the heat of our bodies from escaping so rapidly as it would otherwise do.[14]

Here, Caroline mistakenly began to credit her flannels with the power of preventing a chill; Mrs. B. gently reminded her of previous knowledge she has learnt (that "cold is only a negative quality"), and she could then come to the "true" explanation for why she is kept warm. This question-and-answer process was further complemented by simple sensory experiments that could readily be reproduced in the house, using

[9] See Carter, "On an Object Lesson" for the dedicated cards; David Layton, *Science for the People: The Origins of the School Science Curriculum in England and Wales* (London: Allen & Unwin, 1973), 95–117, for more on teaching "the science of common things."
[10] See the introduction of "familiar science" in Keene, *Object Lessons*, 259–64.
[11] For more on Marcet and Parkes and the significance of their chosen literary forms of "dialogue" and "catechism," see David Knight, "Accomplishment or Dogma: Chemistry in the Introductory Works of Jane Marcet and Samuel Parkes," *Ambix* 33 (1986): 94–98.
[12] Marcet, *Conversations on Chemistry*, 62.
[13] Marcet, *Conversations on Chemistry*, 68.
[14] Marcet, *Conversations on Chemistry*, 70.

no specialist equipment; and (as had been enacted when touching the objects of the room to test for their conductive properties) deployed the body as scientific instrument; for instance:

> If you hold a finger of one hand motionless in a glass of water and at the same time move a finger of the other hand swiftly through water of the same temperature, a different sensation will be soon perceived in the different fingers.[15]

The bare fingers and two glasses of water were all that was required to communicate and embody this particular facet of chemical knowledge. More specialist equipment was also introduced to these demonstrations, for instance a phial of amber which, when placed in hot water, was used to visualise circulating currents; bringing out a visual sensory experience as well as these haptic experiences of touch and temperature.[16]

Household chemistry

The expectation that many of these literary depictions of experiments were to be translated into real-life occurrences, not just remain vicarious representations, was clear from the emphasis on the ease with which they could be conducted with objects literally at hand: the room's furnishing and fire; a glass of water. Reviewing one introductory chemical conversation at the beginning of the century, evangelical educationalist Mrs Trimmer acknowledged the likelihood of going beyond mere reading of these introductions to pursue practical work. In her periodical the *Guardian of Education* she expostulated that she was: "not amongst the number of those who would teach *Chemistry* to Children; it is a fascinating thing, likely to occupy their thoughts and attention to the exclusion of more important subjects, and to put them upon dangerous experiments."[17] John Joseph Griffin went further in the introduction to his immensely popular *Chemical Recreations* in the early 1820s, to claim that mere textual teaching would not suffice; it was precisely those sensory experiments Mrs Trimmer decried as "dangerous" that were needed by students:

> The hearing of lectures, and the reading of books, will never benefit him who attends to nothing else; for Chemistry can only be studied to advantage *practically. One experiment*, well-conducted, and carefully observed by the student, from first to last, will afford more knowledge than the mere perusal of a whole volume. It may be added to this, that chemical operations are, in general, the most interesting that could possibly be devised — Reader! what more is requisite to induce you to
>
> MAKE EXPERIMENTS?[18]

[15] Marcet, *Conversations on Chemistry*, 72.
[16] Marcet, *Conversations on Chemistry*, 77.
[17] Sarah Trimmer, "A Tea Lecture — page 69," *The Guardian of Education* 3 (1803): 310.
[18] John Joseph Griffin, *Chemical Recreations: A Series of Amusing and Instructive Experiments*, 3rd ed. (R. Griffin, Glasgow; E. West, Edinburgh; T. Tegg, London, 1824), 3. Griffin's work, and the late eighteenth- and early nineteenth-century precedents for "practical texts," is discussed in Brian Gee and William H. Brock, "The Case of John Joseph Griffin. From Artisan-Chemist and Author-Instructor to Business-Leader," *Ambix* 38 (1991): 29–62, 34.

For Griffin it was not sufficient to remain a "reader" — his audience must be exhorted, in capital letters, no less, to "make experiments." Such experiments could begin at home: Griffin included instructions for "home-preparations such as the detection of copper in green tea or the making of ginger-bread powder."[19] Edwin Lankester echoed these comments when reviewing James F. W. Johnston's (1855) *Chemistry of Common Life* in the *Athenaeum*, connecting the "operations of the senses" to learning facts:

> it is a great mistake to suppose that chemistry, or any of the natural sciences, can be taught, or that they can become methods of education, by mere reading. The laws of natural science are derived from observation and experiment, and a correct knowledge of the import and value of these laws can only be imparted through the operations of the senses on the facts they embrace. It is useless to expect to teach natural science without museums, apparatus, experiments, and specimens.[20]

As Johnston's book did not contain any directions for specific experimentation, readers relied on the everyday activities he described to provide such sensory experiences, "apparatus, experiments, and specimens" that could readily be found around the home. Without them, such education was avowedly "useless." In his own educational, authorial and chemical career, Johnston continued to emphasise this need for a greater prestige and position for the sciences, for instance with the British Association for the Advancement of Science. He also incorporated "highly practical" components into his courses at the University of Durham.[21]

When introducing the series of experiments that appended his *Household Chemistry*, Derbyshire chemical lecturer Albert Bernays (1823–1892) affirmed the importance of actual everyday experiences in converting common objects into conveyors of scientific facts:

> CHEMISTRY is a science so dependent on experiment, that it may be averred that a man may spend a life-time in reading about it, without attaining to any satisfactory knowledge on the subject. We may read about the changes which the air undergoes in the processes of respiration and combustion — we may hear that a burning candle gives off water and carbonic acid — we may see a blue-bell on the solitary heath become red during a thunder-storm: — but how much more do these become facts to our minds, when we can prove these results to be constant and ever-recurring under similar circumstances. I need, therefore, offer no apology for suggesting a series of experiment on the subjects treated of in this little volume.[22]

[19] Gee and Brock, "John Joseph Griffin," 38.

[20] Edwin Lankester, "Review — *The Chemistry of Common Life*," *Athenaeum* 1432 (1855): 402–03, 402.

[21] For more on Johnston's life and teaching career at Durham University, see David Knight, "James Finlay Weir Johnston (1796–1855)," in *Dictionary of Nineteenth-Century British Scientists*, ed. Bernard Lightman (Bristol: Thoemmes Continuum, 2004), 1093–96; or David Knight, "Johnston, James Finlay Weir (1796–1855)," in *Oxford Dictionary of National Biography*, ed. Brian Harrison (Oxford: Oxford University Press, 2004). http://oxforddnb.com/view/article/14942 (accessed 8/11/12).

[22] Albert J. Bernays, *Household Chemistry: or, Rudiments of the Science Applied to Every-Day Life … New and Enlarged Edition*, 2nd ed. (London: Samson Low & Son, 1853), 245.

For Bernays, sniffing burning candles and watching storm-buffeted bluebells were best complemented with a "series of experiments"; indeed, it was by building upon such known experiences that one could attain a "satisfactory knowledge" of the science of chemistry. Mere reading, even for a "life-time," would not provide an adequate means of introduction to the topic without practical explorations. It was only through sensory impressions that such information was made scientific, becoming "facts to our minds." These commitments were evident throughout the successive editions of Bernays' book, which had originated as school lessons for his brother's classes at Elstree School, but which took for their starting-point the objects and activities of the household. For example, on 10 December 1853, the *Lady's Newspaper* carried the following announcement:

> Hyde-park College for Young Ladies, 31, Westbourne-terrace. — Classes in Chemistry. — Mr. Albert J. Bernays proposes to deliver in this Institution a course of ten lectures illustrated by numerous experiments, on the plan adopted by him in his late work, entitled, "Household Chemistry." It is not the intention of these lectures to make ladies chemists, but to instruct them in [various scientific topics]… as far as they bear upon the daily events of common life. Under these heads the lecturer proposes to explain and illustrate the rationale of all ordinary household operations; such as cooking, brewing, washing, bleaching, &c., &c.; and to show the principles upon which the rules are founded. At the same time sufficient of the rudiments of Chemistry will be laid down to give a foundation for and inducement to the farther pursuit of a science so well deserving the best attention of all.[23]

"[O]rdinary household operations" and the "daily events of common life," including "cooking, brewing, washing, bleaching," and more, were the starting-points for Bernays' brand of familiar chemistry. This was explicitly intended as both "foundation" and "inducement to the farther pursuit" of the science: both boys and girls were encouraged to go on to more extensive investigations, and to reconfigure their existing activities along chemical principles. Those attending the "Classes in Chemistry" at Hyde Park College could go on to further study by purchasing Bernay's book, published earlier that year.[24] This presented the bearer of chemical knowledge as a superior domestic expert, able to unveil the scientific forces at work in the home and better put them to use: as its subtitle declared, it emphasised how "that science" could be "applied" in "every-day life."

A well-respected chemical analyst and lecturer, Bernays had conducted research at Giessen under Liebig on limonin, found in the everyday comestibles of oranges and limes; and credited Liebig's (1847) *Chemistry of Food* as one of the chief inspirations for *Household Chemistry* and its organisation.[25] *Household Chemistry* was

[23] Anon., "Classes in Chemistry," *The Lady's Newspaper* 363 (1853): 354.

[24] Albert J. Bernays, *Household Chemistry: or, Rudiments of the Science Applied to Every-Day Life* (London: Samson Low & Son, 1852).

[25] Bernays, *Household Chemistry* (1852), xiv–v; Justus Liebig, *Researches on the Chemistry of Food*, ed. William Gregory (London: Taylor and Walton, 1847). For more detail on Bernays, see: P. J. Hartog, "Bernays, Albert James (1823–1892)," in *Oxford Dictionary of National Biography*, rev. Anita McConnell (Oxford University

indebted to another towering figure of the age, having been named for Charles Dickens' new periodical *Household Words*, the chemical articles of which were admired by Bernays.[26] The book, he emphasised, was not intended for "regular students of Chemistry," who would be better placed reading Liebig and others; rather, it was for "the young," and for the kind of reader expected by *Household Words*: "those who, although people of general education, witness in the processes of daily life, some of the most important chemical operations … without either knowing or heeding" the scientific laws at work.[27] Once again, it was familiarity that was seen as the cornerstone of the work, Bernays offering "a familiar explanation of these chemical phenomena, in a familiar form."[28] Armed with this knowledge of *Household Chemistry*, his readers would not only have "many errors" corrected, they could also do "some things better and more effectually," or even, given "sufficient talent and leisure," "enter upon the serious study of science."[29]

The book sold well, and was quickly revised into a second and third edition. However, with each iteration, Bernays tweaked the content and layout of the work, making it more suitable for use in school and for students, and less like an introductory work for the general reader in the family home. The second edition of 1853 was "thoroughly revised" and "rearranged," with questions added "to the end of each chapter to increase its suitableness as a school-book."[30] For example, Chapter I in the first edition on the "Chemistry of the Breakfast-Table" was moved to Chapter III; rather than beginning with its readers at the commencement of the quotidian routine, the "Chemistry of the Atmosphere" was deemed the more appropriate opening for the book.[31] The new list of suitable questions on this chapter encapsulated the range of knowledge that could be introduced by the work's familiar expositions, and included the rather basic "What are the names of the subjects of breakfast, of which this chapter treats?", as well as:

> What is another striking property of water? What substances abound most in water? What constitutes hard and soft waters? Of the gases with which we are familiar, which is most and which least soluable? Is the solvent power of water important? How does it affect fishes? How may water be proved to be a compound?[32]

What could be useful to a group of students guided by a teacher became an overwhelming barrage of different topics, from gas to fish. The third edition of 1854 went even further in converting its printed format for different users: "numerous

[25] *Continued*
Press, 2004; online ed., September 2012). http://oxforddnb.com/view/article/2254 (accessed 5/11/12); Anita McConnell, "Bernays, Albert James (1823–1892)," in *Dictionary of Nineteenth-Century British Scientists*, ed. Lightman. 197–98.

[26] Bernays, *Household Chemistry* (1852), xv.

[27] Bernays, *Household Chemistry* (1852), xiii.

[28] Bernays, *Household Chemistry* (1852), xiii

[29] Bernays, *Household Chemistry* (1852), xiii–xiv.

[30] Bernays, *Household Chemistry* (1853), v.

[31] Bernays, *Household Chemistry* (1852), 1–28; Bernays, *Household Chemistry* (1853), 57–90.

[32] Bernays, *Household Chemistry* (1853), 88.

illustrations" were added in to the text, which was now given numbered paragraphs, and the appendix "entirely rewritten."[33]

Lessons on objects

While the surviving textual materials often provide the means of historical access to past educational practices, books and periodicals were just one way in which children came to know about the sciences: one of the best-known examples of familiar chemistry from early Victorian Britain was a juvenile lecture, Michael Faraday's Royal Institution object lesson on *The Chemical History of a Candle*.[34] In his recent edition, Frank James traces Faraday's first lectures on the candle to his Afternoon Lectures series "Upon Some Points of Domestic Chemical Philosophy" given in June 1831, the very title of the series emphasising its connection to the household.[35] The lectures were recycled at several points for Royal Institution audiences, and also inspired a series of articles in Bernays' favoured *Household Words*, before being fully published with accompanying illustrations by William Crookes in 1861.[36] The lectures used the common household commodity to introduce the sciences: as Faraday declared, "there is not a law under which any part of this universe is governed which does not come into play and is touched upon in these phenomena." The "physical phenomena of a candle" would be an "open door by which you can enter into the study of natural philosophy"; indeed, he claimed, there "is no better, there is no more open door."[37] By grabbing hold of a candle, his juvenile audience could be connected to a scientific understanding of the entire cosmos.

Faraday began his lectures with an analysis of the different substances of which candles are made, introducing his "boys and girls" to:

> candles as they are in commerce. Here are a couple of candles commonly called dips. They are made of lengths of cotton cut off, hung up by a loop, dipped into melted tallow, taken out again and cooled, then re-dipped, until there is an accumulation of tallow round the cotton. In order that you may have an idea of the various characters of these candles, you see these which I hold in my hand — they are very small and very curious.[38]

[33] Albert J. Bernays, *Household Chemistry … Third Edition, Considerably Enlarged* (London: Sampson Low and Son, 1854), v.

[34] Michael Faraday, *The Chemical History of a Candle* (London: Griffin, Bohn & Co., 1861).

[35] Frank James, "Introduction," in Michael Faraday*The Chemical History of a Candle*, (Oxford: Oxford University Press, 2011), xiii–xlii, xxi–xxii.

[36] Percival Leigh, "The chemistry of a candle," *Household Words* I (1850): 439–44; Percival Leigh, "The laboratory in the chest," *Household Words* I (1850): 565–69; Percival Leigh, "The mysteries of a tea-kettle," *Household Words* II (1850): 176–81; Faraday, *Chemical History of a Candle*. On Leigh, see W. A. J. Archbold, "Leigh, Percival (1813–1889)," *Oxford Dictionary of National Biography*, rev. Katharine Chubbuck (Oxford University Press, 2004; online ed., September 2012). http://oxforddnb.com/view/article/16388 (accessed 12/11/12).

[37] Faraday, *Candle*, 1–2.

[38] Faraday, *Candle*, 2–4.

A crucial part of the introductory process was the fact that Faraday appealed to common commercial candles that he had brought in as actual examples: in a common trope of contemporary object lessons, he emphasised that he held the "small" and "curious" objects in his hand. The emphasis on first-hand experimenting with candles, and the possibility of his audiences' own experimentation, continued throughout the lectures; for example, he asked the listening children to "go home and take a spoon that has been in the cold air and hold it over a candle — not so as to soot it — you will find that it becomes dim just as that jar is dim."[39] Once again, familiar objects were employed to embody basic scientific principles, both in discussing the household in the lecture, and back home after the lecture had finished: further practice was foregrounded and anticipated. Faraday also exploited different levels of familiarity in the lectures; for instance, he used an opportunity in the third lecture, when given on New Year's day 1861, to refer to a sudden thaw that had led to many burst pipes in his audiences' homes, and displayed two Japanese candles sent to him by an audience-member before his final lecture.[40] Throughout, he used live demonstrations to bring the topic to life, and more effectively communicate his material. As one account emphasised: "He never *told* his listeners of an experiment, he always *showed* it them … 'inform the eye at the same time as you address the ear.' This was the great secret of Faraday's success."[41] Such an emphasis on performance meant that Faraday was sceptical over whether the staged events of the lecture hall could translate onto the printed page; but was, as James writes, convinced by Crookes that verbatim transcripts and woodcut images in which the lecturer's hands lurked were able to capture and recreate a sufficiently redolent experience.[42] By the end of the book and of the lectures, Faraday had beatified his actual and virtual audience-members into candles themselves, reemphasising his natural philosophical message with religious echoes, urging them similarly to "shine as lights to those about you."[43] They would go forth to both learn more about familiar chemistry, and make chemistry familiar to others.

Just as Faraday's active demonstrations were preserved in printed forms, so, conversely, written books were intended as enticements to active practical investigations. For instance, each edition of Bernays' *Household Chemistry* had concluded with "a number of useful and simple experiments, many of which may be understood and performed by a child of eight years old."[44] The first series of these experiments explicitly required "no apparatus beyond what is to be found in every household," and began with observing what happened when a candle was lit:

[39] Faraday, *Candle*, 53.
[40] James, "Introduction," xxiii.
[41] Quoted in James, "Introduction," xxii.
[42] James, "Introduction," xxvi.
[43] Faraday, *Candle*, 171.
[44] Bernays, *Household Chemistry*, (1853), viii.

> 1. Take a fresh candle and light it. Mark the carbonisation or apparent blackening of the wick, the melting of the tallow, its rise into the wick, the form of the flame, and the division of the wick into the part which consumes away and that which is simply soaked in tallow.

The habitual and mundane activating of lighting a "fresh candle" was made the centre of attention, as the experimenter was told in imperatives to "take" the object, and "mark" the phenomena to be observed. The separate parts of the candle — wick, tallow, flame — were identified, and the processes by which they were inter-related elucidated. When new vocabulary such as "carbonisation" was used, it was immediately defined as "apparent blackening"; other observations, such as how the tallow could "rise into the wick," or the "form of the flame" were to be remembered for future use. Once sufficient details had been drawn out of the usual activity of lighting the candle, more unfamiliar experiments were encouraged, as the candle was manipulated in novel ways:

> 2. Move the candle quickly through the air, and note carefully the results, as regards smell, smoke, &c. Hold a dry plate immediately over the flame — carbon is deposited; some distance above it — the plate is not soiled.

Once again, it was the everyday objects of candle and plate that were employed as apparatus; yet here they were not used in their familiar ways, but manipulated in a sensory experimental manner, with the pupil told to "note carefully the results, as regards smell, smoke, &c." The lessons drawn from these investigations were then taken even further — to be extended by being compared to a repetition of the experiment with an oil-lamp, rather than a candle:

> 3. Try at what distance immediately above the flame it ceases to light or even charr a piece of paper. – Repeat the experiment with a lighted camphine or oil-lamp, and find out why the paper will inflame at a much greater distance from the flame than a candle not surrounded by a lamp-glass.[45]

It was through trial and error — with potentially conflagratory consequences — that children were supposed to "find out why" these objects acted in certain ways, as they began to learn experimental techniques of manipulation, observation, repetition, recording of results, and comparison.

Another example included in these experiments using everyday objects at the end of Bernays' book was an exploration of what happened to grains of soap in different types of water:

> Dissolve a few grains of hard soap in clean rain-water, and add a few drops of this solution to hard-water. You will find the soap curdle. The lime of the water forms, with the fatty acids of the soap, a greasy insoluble lime-soap, while the soda of the hard soap combines with the sulphuric acid with which the lime of the hard water is usually associated.

[45] Bernays, *Household Chemistry*, (1853), 245–46.

> Until, therefore, the lime is thrown down from the hard water, the soap will not begin to act as a cleansing agent.[46]

By this stage, chemical terminology such as "sulphuric acid" was thrown into the discussion along with the soapy solution; the observations to be made were confidently asserted ("you will find"), and the reasons for this elaborated, relying on existing knowledge of, for instance, the meaning of "insoluble." This example was an experimental version of the ablutionary observations made by Charles Foote Gower in his *Scientific Phenomena of Domestic Life* in house and garden, a text that began before breakfast to stalk the daily activities of its reader from morn till night. By the 1847 second edition, the book's subtitle had been revised to emphasise how the book was *Familiarly Explained*, as Gower foregrounded his use of everyday occurrences as well as the particular type of language he would employ.[47] Indeed, he opened his chapter on the "bed-room" with a caveat that, due to his "treatise being intended more especially for the perusal of the young," he would sometimes "[descend] to what might otherwise be deemed examples too familiar to require explanation."[48] The "daily routine of life" was in this way converted into a series of illuminating chemical lessons.[49] For instance, the daily morning encounter with the wash-tub was taken as an example of the scientific processes that occurred when soap and water were mixed:

> In performing our morning ablutions we shall probably be led to remark the difference between hard and soft water, as they are commonly termed, and the difference of their actions upon soap. Hard or spring water, though originally rain, has, by filtering through the earth for a considerable time, imbibed many impurities, by having come into contact with various earthy and mineral substances through which it has passed. These impurities, when using soap with hard water, have the effect of decomposing the soap, and preventing its solution with the water, on which the washing properties of the soap depend.[50]

Building up from how substances are "commonly termed," Gower explained the "washing properties" of soap due to the "impurities" in the water, and ensured that the reader could now explain the "difference between hard and soft water" for one's "morning ablutions" as well as it being a matter of "remark."

For more advanced students, and those willing to spend "a few shillings" on specialist apparatus to augment the contents of the kitchen cupboards, one of Bernays' next series of more complex experiments detailed the spectacular properties of potassium, which, as he informed his reader, was the basis of potash, and

[46] Bernays, *Household Chemistry* (1853), 250–51.
[47] Charles Foote Gower, *The Scientific Phenomena of Domestic Life: Familiarly Explained*, 2nd ed. (London: Longman, Brown, Green and Longmans, 1847).
[48] Gower, *Scientific Phenomena*, 8.
[49] Gower, *Scientific Phenomena*, 8.
[50] Gower, *Scientific Phenomena*, 19–20.

found in soft soap and glass. This was one of the more sensually exciting of the experiences he outlined, creating both burning substances and burning tastes:

> A small piece of the metal thrown into a few drops of water in a saucer, bursts into flame, is carried rapidly about, and is quickly dissolved. The water is decomposed; its oxygen unites with the potassium and dissolves, whilst its hydrogen is inflamed by the heat of the combustion, and burns with a violet flame — the color being due to admixture with a little volatilized potash. The remaining water will be found on examination to possess a caustic (burning) taste, and to blue reddened litmus paper.[51]

Thus, these experiments began to take the reader far away from their everyday experiences of soap, and demonstrate the hidden alien natures of these commodities.

As Bernays introduced his article on "the chemistry of soap," this product connected the home to the factory to the chemical laboratory: "in a chemical point of view, the manufacture of soap is extremely interesting, and forming as it does one of the most important articles of domestic use, a short account of its composition, and the process of its manufacture, should not be omitted in a work professing to illustrate household chemistry."[52] George Dodd's account of "A Day at a Soap and Candle Factory," one example of the "factory tourism" genre of writing popular with family audiences in the 1840s and 1850s, emphasised the ironically smelly and dirty experience of soap's manufacture:

> Near the frame-room is a range of ware-rooms, in which the slabs of soap are cut up into bars, and then piled up in tiers, like bricks in a wall. If "cleanliness is next to godliness," according to the old adage, we ought to have very pleasant thoughts while passing between these walls of soap — here "mottled" — there "yellow" — in another part "curd," and so on; but the truth is, that the odour from such a mass of soap, and the unavoidable absence of cleanliness in the manufacture, somewhat disturb the pleasure of contemplating the ulterior purpose to which the soap is to be applied.[53]

In his *Chemistry of Common Life*, Johnston included a section on smells produced by such factories, which, he argued: "materially affect, at times, the comforts of common life." Advocating a ban on the "intentional discharge" of "injurious substances," he referenced the "soap and candle makers" in particular, who "[dissipated] into the air the volatile fetid substances which naturally exist in long-kept and rancid fats. As a result of some of these processes, also, they produce and send forth vapours of the irritating and unpleasant acrolein."[54] An emphasis on the senses was again appropriate: the ironically smelly and dirty soap and candle

[51] Bernays, *Household Chemistry* (1853), 264–65.
[52] Bernays, *Household Chemistry* (1853), 185.
[53] George Dodd, *Days at the Factories or, the Manufacturing Industry of Great Britain Described, and Illustrated by Numerous Engravings of Machines and Processes. Series I. — London.* (London: Charles Knight, 1843), 190. This book was a collection of Dodd's journalism for Knight's publications, associated with the Society for the Diffusion of Useful Knowledge and contemporary attempts to expand the audiences for scientific writings, such as the *Penny Magazine*.
[54] James F. W. Johnston, *The Chemistry of Common Life* (Edinburgh and London: William Blackwood and Sons, 1855), vol. II, 300–2.

factories were seen to be the objects whose productions *most* deleteriously affected the bodies of nearby inhabitants.

In these ways, two emblematic early Victorian commodities were used by writers to introduce a range of scientific phenomena to young audiences. Rather than just thinking more about familiar practices already engaged in at home, these works demonstrated unfamiliar processes, and could take readers on imaginative journeys to the sites of these processes: Faraday's candle could open the doors to the factory, as well as to the Royal Institution. With these objects Victorian children moved beyond the simple recapitulation of household activities to elucidate scientific theories, and could begin to experience the unfamiliar effects produced through new types of chemical manipulation. By following the experimental directions detailed by lecturers, or appended to introductory texts, they began to enact new types of experiments with increasingly novel objects. They could thus comprehend and manage the spectacular in the everyday, such as the explosive properties of potassium, or Dodd's overwhelming spectacle of the factory. Nevertheless, not all chemical experiments could be illustrated with objects found around the house: at some point specialist equipment would be required.

Footsteps to experimental chemistry

From early in the nineteenth century several chemists and chemical outfitters had produced sets with which elementary experiments could be conducted in a small space in the home, claiming such apparatus was a vital accompaniment to the many introductory treatises on the subject: it was only through physical engagement with objects that beginners could really learn about chemistry.[55] Robert Best Ede's "No.1 Youth's Laboratory, or Chemical Amusement Box" first appeared around 1836–1837 and sold for a price of 16 shillings. It was advertised as "containing more than 40 Chemical preparations and appropriate apparatus, for enabling the enquiring youth … to perform above 100 Amusing and Interesting Experiments with perfect ease and free from danger."[56] This introductory set included a range of equipment, from Funnel, and Test Tube, to Spirit Lamp, Retort Stand, Two Watch Glasses, and Litmus Paper, alongside various chemicals, all labelled according to Ede's standardised system. The company's acclaimed earlier portable laboratories (see Figure 1), marketed from 1835, had been designed to accompany the 1834 7th edition of Griffin's *Chemical Recreations*; but after Griffin's book went out of print in 1837, Ede himself produced *Practical Facts in Chemistry*: as he phrased it, a "key" with which to unlock his larger cabinets.[57] The Youth's Laboratory also had its own dedicated guide: the "plain and simple instructions" of *Ward's*

[55] See especially, Gee, "Amusement Chests and Portable Laboratories."
[56] Robert Best Ede, *Practical Facts in Chemistry* (London: Thomas Tegg; Simpkin, Marshall and Co., 1837), endpapers.
[57] Ede, *Practical Facts*, endpapers; John Joseph Griffin, *Chemical Recreations: A Series of Amusing and Instructive Experiments*, 7th ed. (Glasgow: R. Griffin; London: Thomas Tegg, 1834). Incidentally, to obtain a locked version of Ede's "Youth's Laboratory" you would have had to have paid £2 2s 0d for the No. 3 version.

FIGURE 1 Robert Best Ede's "Portable Laboratory." Wellcome Library, London.

Companion; or Footsteps to Experimental Chemistry.[58] This textual accompaniment, a 36-page pamphlet written by Ede's London agent, was from the beginning conceived of as essential to the Laboratory's success, and reviewers urged that "Mr. Ward's *Companion* ought to be *every body's companion* — and his *Footsteps* cannot be too closely followed by the student who would arrive at distinction in the science."[59]

Despite his readers presumably having purchased a "Youth's Laboratory" alongside their guidebook, an image of which was engraved as an image on the title page (see Figure 2), the first of Ward's experiments did not use the contents of the chemical box at all, rather the everyday domestic items of water, sugar, and a tea-spoon, as he detailed exactly the same kind of elementary household experiment outlined by Bernays, or even Marcet:

> EXPERIMENT I
>
> To discover whether any substance is soluble in water, is easily ascertained by suspending it in the fluid. For instance, by holding a lump of sugar fastened by a thread, or in a tea-spoon, in a glass of clear water; if it be soluble, you will observe a stream of bubbles continually descend until it is all gradually dissolved or melted away; and so, you will no longer be able to perceive its presence in the fluid, nor discover it, except by taste, or by some other means by which you may detect its presence: to do this you must employ some re-agent which shall exhibit its existence in the solution.[60]

By beginning with a sugar solution, Ward not only punned on the supposed purpose of these texts to "sweeten the lip of the cup of knowledge," he also revealed that the act of tasting was itself an art of testing. As with the haptic comparisons Marcet had encouraged her readers to make by feeling the temperature of various objects in the room, this use of the tastebuds as an instrument could be conceived of as a continuation of Lissa Roberts' "sensuous technologies."[61] More importantly, however, Ward decided not to start his book with a spectacular demonstration of something strange and new and wonderful: instead he chose the mundane dissolving of a lump of sugar. He thereby and explicitly connected the activities of the "Youth's Laboratory" to the kind of household experiments previously discussed in this article — experiments with which his young readers might well have been familiar.

Many introductory chemical works in this period used this middling combination of household and specially purchased equipment: Samuel Parkes' *Elementary Treatise* (1839), for instance, contained many such directions, of which the following are illustrative: in the first, the reader combined the tea-cup (everyday) with the bell-glass (chemical) to perform that reversed miracle of turning wine into water; in

[58] John Ward, *Ward's Companion; or, Footsteps to Experimental Chemistry* (London: Thomas Tegg, 1837).
[59] Anon., "Ward's Companion … ," *Christian Remembrancer* 20 (1838): 728.
[60] Ward, "*Footsteps to Experimental Chemistry*," 14.
[61] Lissa Roberts, "The Death of the Sensuous Chemist: The 'New' Chemistry and the Transformation of Sensuous Technology," *Studies in History and Philosophy of Science* 26 (1995): 503–29.

WARD'S COMPANION;

OR,

Footsteps to Experimental Chemistry:

CONSISTING OF BRIEF OUTLINES AND DIRECTIONS TO THE

YOUNG CHEMIST,

FOR PERFORMING, BY MEANS OF SIMPLE APPARATUS, WITH FACILITY AND SUCCESS,

A SERIES OF VARIED AND INTERESTING EXPERIMENTS,

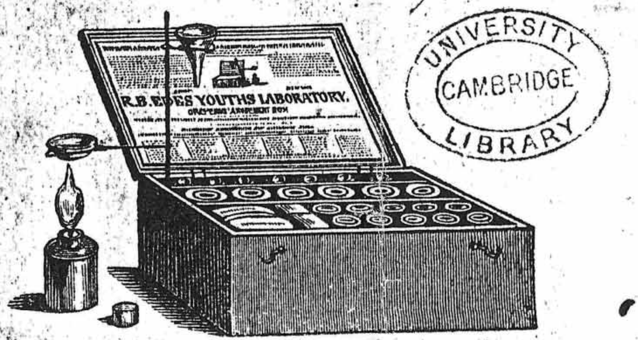
With an attempt to explain the

THEORY AND RATIONALE;

TOGETHER WITH SOME HINTS ON CHEMICAL MANIPULATION;

AND ALSO INTENDED AS

A Guide to R. B. Ede's Youth's Laboratory.



BY JOHN WARD.

London:

PUBLISHED BY THOMAS TEGG & SON, CHEAPSIDE;
SIMPKIN, MARSHALL, AND CO., STATIONERS' HALL COURT;
S. HIGHLEY, FLEET STREET;
AND SOLD BY THE AUTHOR, 79, BISHOPSGATE STREET WITHIN.

1837.

ENTERED AT STATIONERS' HALL.——PRICE EIGHT PENCE.

FIGURE 2 Title page to *Ward's Companion* (1837). Reproduced by kind permission of the Syndics of Cambridge University Library. Classmark: 8340.e.13.

the second, the colour of a rose (everyday) was changed by suspending it in a gas jar (chemical) and exposing it to the fumes of a match (everyday):

> EXPERIMENT
>
> Put a little alcohol in a tea-cup, set it on the fire, and invert a large bell-glass over it. In a short time an aqueous vapour will be seen to condense upon the inside of the bell, which by means of a dry sponge may be collected, and will be found to be pure water.
>
> EXPERIMENT
>
> Suspend a red rose within a glass jar similar to that in the annexed engraving, and in that situation expose it to the confined fumes of a brimstone match. This will soon produce a change in its colour, and at length the flower will become quite white.[62]

Therefore, we can see that there was no clear divide between the kind of experiments that could be conducted with everyday commodities and those requiring the contents of the chemical cabinet. Both these more practical guides as well as didactic dialogues demonstrated a great continuity between these familiar and specialist objects.

The way in which these texts were written, however, differed considerably from the more narrative styles employed by authors such as Gower, or the didactic dialogue of works such as Marcet's; moving away from the "familiar format," they more closely resembled the closing series of experiments from Bernays's book. The clearest example of how a series of elaborate instructions detailing how to perform a particular chemical manipulation were first outlined, then encoded in a handier and singular imperative, can be seen in Experiments II and III of Ward's text. Experiment II provided a lengthy articulation of how to evaporate a substance:

> EXPERIMENT II
>
> Take a few grains of the superoxalate of potass, and dissolve in a tea-spoonful of water; then having fixed the brass rod and triangle (as shewn in woodcut), put the solution into a watch-glass, and place it on the triangle; then light the spirit-lamp, and very gently and gradually apply heat to the watch-glass, to prevent its cracking by a too sudden expansion, and continue it until the water rises in the form of vapour; and after a time a thin film will appear on the surface; then gradually lessen the heat, and take away the watch-glass, and put it in some place where it will not be disturbed. In a very short time you will find the crystals of the superoxalate of potass reformed; but if the water has not been sufficiently evaporated, the crystals will not be formed, and it will be necessary to repeat the process, and continue it a little longer, and then again put it aside to crystalise.
>
> After the crystals are formed there is usually a little water remaining, which is called the mother-water, and in simple crystalisations of this nature may be thrown away. The crystals are to be thrown on a piece of blotting-paper, so that any moisture adhering to them may be absorbed, and the perfect crystals obtained dry.[63]

[62] Samuel Parkes, *An Elementary Treatise on Chemistry, upon the Basis of the Chemical Catechism* (London: E. Palmer, 1839), 50; 121. For more on Parkes' *Chemical Catechism*, see David Knight, "Accomplishment or Dogma: Chemistry in the Introductory Works of Jane Marcet and Samuel Parkes," *Ambix* 33 (1986): 94–98.

[63] Ward, *Footsteps*,14–15.

The detailed instructions, quoted here in full, were lengthy: they gave quantities (a tea-spoonful of water); showed how to set up the appropriate apparatus (by directions and the accompanying woodcut image); warned of potential dangers (cracking the watch-glass); and directed the repetition of the process should the desired result not be obtained. Terminology not introduced in the earlier "theoretical" sections, such as "mother-water," was explained. But by the following experiments, all these processes of experimentation could be themselves boiled down to one sentence:

> EXPERIMENT III
>
> Take a solution of the bi-chromate of potass, evaporate, and crystals of a beautiful garnet colour will be formed.
>
> EXPERIMENT IV
>
> Evaporate a solution of the prussiate of potass, and lemon-coloured crystals will be produced.[64]

The emphasis on gestural control (gently heating), on what equipment to use, even on quantities, had disappeared, as had the figure of the experimenter. Rather than a potentially fallible process, the experiments became certain and passive demonstrations of fact: "lemon-coloured crystals *will be* produced." There was no longer any room to go wrong.

I have chosen these experiments of evaporation partly because they were supposedly some of the first experiments children would have attempted to perform, but also because the processes they described neatly provide suitable language to communicate what Ward found to be the "difficult" operations of writing out experimental instruction — converting text into practice. Rather than a detailed elaboration, this was itself a process of reductive concentration, as Ede revealed in the preface to his *Practical Facts in Chemistry*. Within its pages the reader would find "the technical phraseology, in which the sciences are too often obscured, reduced to the most familiar and simple form consistent with the dignity of Chemistry."[65] However, elsewhere reviewers would take issue with Ede's assertion that he was writing in a "most familiar" form: to the *Christian Remembrancer*, Ede appeared to be a "tyro in literature," though his technical skill and "practised hand" was also apparent in the work.[66] In fact, self-consciously employing a "technical phrase," the reviewer claimed Ede had produced "*crumpled*" language.[67] Despite these "inelegancies," the reviewer did recommend the work for all those requiring a "very practical" introduction to chemistry.[68] Like the text, Ede's sets were also an exercise in reduction: the *Times* applauded how Ede had "managed to condense into as small a form as possible a considerable number of chymical

[64] Ward, *Footsteps*, 15.
[65] Ede, *Practical Facts*, ix.
[66] Anon., "Practical Facts in Chemistry," *Christian Remembrancer* 19 (1837): 162.
[67] Anon., "Practical Facts," 162. Emphasis original.
[68] Anon., "Practical Facts," 162.

tests, and re-agents."[69] Ede reported in his advertisements that the *Bury and Suffolk Herald* declared that "the concentration, in so small and elegant a form, of all that is requisite for practical experiments, cannot fail to be duly appreciated by all interested in the study."[70] However, more importantly, such linguistic processes rendered the experiments transcendent, as these advertisements articulated: like the small (and supposedly affordable) boxes, the sugar, soap, and candles, the experimental instructions could travel between many different places, and bring these types of chemistry to new audiences. Not everything was conserved in this distillation, however: the reductive prose did not include the rich digressions on etymology, history, and industry that were included in more descriptive works of familiar chemistry, and which for some were just as important.

In an article selected to be bound with Ede's book itself, the *Leicester Herald* echoed the language of concentration when reviewing Ede's Portable Laboratories, stressing elegance, refinement and the suitability of the product for many different rooms of the house:

> we have concentrated in an elegant and ornamented Cabinet, adapted equally for the Library of the man of Science, the Studio of the Chemist, or the Boudoir of the Lady amateur, an organized collection of the best contrived modern apparatus, adapted to render the exhibition of refined experiments even in the *drawing room* at once easy and satisfactory.[71]

Similar claims had been made for other products of which Ede's firm was a renowned purveyor: their perfumes, such as the "Hedyosmia," were also deemed suitable for varied domestic spaces:[72] "the purest and most elegant article for the ASSEMBLY, or the BOUDOIR ... the HANDKERCHIEF, the TOILET, or the DRAWING ROOM."[73] Yet the differences between these spaces were asserted by Ede: despite the professed aim of these chemical cabinets to provide a sense of what it was like to be a research chemist, he reminded the purchaser of his laboratory not to expect to be able to (re-)enact all experiments which he encountered in his readings:

> When it is said, that a Portable Laboratory is presented to the student in the compass of a *small box*, let him clearly understand in what sense this is meant. We do not pretend to say, that either one size or the other will enable him to put every fact he may meet with in reading to the proof of experiment, very few Chemists indeed are in a condition to do this, but they are amply sufficient to unfold to his view the phenomena of nature, by making him familiar with a great number of useful and entertaining facts, and giving

[69] Ede, *Practical Facts*, endpapers, 7.
[70] Ede, *Practical Facts*, endpapers, 8.
[71] Ede, *Practical Facts*, endpapers, 8. Emphasis original. Note that both men and women are referred to as potential users of the sets.
[72] It appears that the idea and practicality of turning a perfumery into a chemical toyshop occurred more than once: William Edward Statham, who began trading in rival chemical cabinets in 1839, was originally a wholesaler in perfumes (Gee, "Amusement Chests," 57, footnote 4).
[73] Ede, *Practical Facts*, endpapers, 37.

> him such expertness in manipulation, as will render it easy for him hereafter to widen the sphere of his operations, should he judge it necessary so to do.[74]

In his autobiography, the engineer James Nasmyth likewise emphasised the limitations rather than opportunities created by the pre-packaging of commercial chemical sets. Contrasting the mid-Victorian present with the days before Ede's laboratories, he remembered how, growing up in the 1810s, he and his friend:

> made it a rule … that, so far as was possible, we ourselves should actually *make* the acids and other substances used in our experiments. We were not to buy them ready made … Hence, though often baffled, we eventually produced perfect specimens of nitrous, nitric, and muriatic acids. We distilled alcohol from duly fermented sugar and water, and rectified the resultant spirit from fusel oil by passing the alcoholic vapour through animal charcoal before it entered the worm of the still. We converted part of the alcohol into sulphuric ether. We produced phosphorus from bones, and elaborated many of the mysteries of chemistry. … I feel certain that there is no better method of rooting chemical or any other instruction, deeply in our minds.[75]

Nasmyth lamented that with the production of commercial chemical cabinets such as Ede's, later generations had little experience of real "technical handiness or head work!". "Everything is *bought ready made* to their hands; and hence there is no call for individual ingenuity. … the result, for the most part, of too free a supply of pocket money."[76] Thus, the production of these sets, despite all their rhetoric of providing the means to do experiments, in fact often worked against the wider dissemination of certain kinds of skills, and turned the replication of chemical experiments into a simple matter of combining prepared substances. Users might have imagined they could now have an insight into and experience of what it meant to do chemistry, but in reality they had learnt few practical skills, and chemical instruction had not been "rooted" in their minds. They were effectively boxed in by the contents of the sets, which did not really encourage the independent use of their products; rather, the sets distanced their users from learning certain things about chemistry. Dodd had opened *Days at the Factories* with a reflection on the contemporary distancing of individuals from the means of production of everyday commodities:

> The bulk of the inhabitants of a great city, such as London, have very indistinct notions of the means whereby the necessaries, the comforts, or the luxuries of life are furnished. The simple fact, that he who has money can command every variety of exchangeable produce, seems to act as a veil which hides the producer from the consumer.[77]

Many of the texts I have studied in this article argued in the opposite way, however, and revealed how their audiences were made aware of how objects had been produced — where they had come from, what they were made of. Indeed, it was this

[74] Ede, *Practical Facts*, 2. Note that Ede assumes his student is male.
[75] Samuel Smiles, ed., *James Nasmyth Engineer: An Autobiography* (London: John Murray, 1883), 95–96.
[76] Smiles, *Nasmyth*, 96.
[77] Dodd, *Days at the Factories*, 1.

appetite for such stories hidden in the artefacts of everyday life, and a sense of their importance as the best way of bringing novel subjects — including scientific disciplines — to new audiences, that brought the familiar and unfamiliar together.

Conclusion

In his best-selling memoir, *Uncle Tungsten*, neurologist Oliver Sacks remembered that when a youthful experimenter his "first taste was for the spectacular — the frothings, the incandescences, the stinks and the bangs, which almost define a first entry into chemistry."[78] A century earlier, in Francis Galton's *English Men of Science* Vernon Harcourt had also claimed his "first taste for chemistry date[d] from the possession of a chemical box, when I was a little boy;" or from "the lectures I attended as a boy, and to the permission to carry on little experiments at home in a room set apart for the purpose. I was encouraged in my tastes at home."[79] This article has explored how mid-nineteenth century children acquired their first tastes for chemistry through such experiences of home experimentation. Moreover, I have taken their chosen metaphor of "taste" quite literally, and argued for the sensory nature of elementary science, and its appeal to beginning audiences. By sipping sugary solutions, charring the wicks of candles, smelling perfumed soap, feeling the heat of objects, and enacting other exciting experiments, they could engage with the chemical world in which they lived. Such "familiar chemistry," I have argued, was a distinctive educational style that reinforced arguments for men of science as domestic experts, and a greater degree of practical experience as a central part of scientific education.

It was these childish tastes and empirical commitments that underpinned the flourishing of "familiar chemistry" in early Victorian Britain. Household activities were identified with chemical processes, and converted into didactic exemplars; crucially, their domestic nature meant they could be engaged in simultaneously with conversation at the breakfast- or tea-table as a central part of familial life. The series of educational practices augmented the well-known literary genre of the "familiar format" with explicit instructions for simple experiments that could be conducted for little cost and primarily employing domestic artefacts, and overlapped with the experimental instructions for pre-packaged chemical cabinets; sensory experience and refinement were demonstrably key to both. Moreover, these lessons were an intervention in contemporary debates over the proper place of the sciences: their writers placed the sciences in general, and chemistry in particular, at the heart of everyday life. A powerful argument for the authority and importance of the sciences, and for men of science as capable domestic experts, such a location revealed

[78] Oliver Sacks, *Uncle Tungsten: Memoirs of a Chemical Boyhood* (London: Picador, 2001), 71. In this passage, Sacks goes on to say that he used a copy of Griffin's *Chemical Recreations* to guide these youthful experiments.

[79] Francis Galton, *English Men of Science* (London: Macmillan, 1874), 158. Admittedly these responses were given to a rather leading question! See discussion in Al-Gailani, "Magic, science and masculinity." For the identification of Harcourt, see Victor L. Hilts, "A Guide to Francis Galton's *English Men of Science*", *Transactions of the American Philosophical Society* 65 (1975): 1–85, 33.

conceptions of who was thought able to practice and understand these disciplines. "Familiar chemistry" as a rhetorical move connected the kitchen to the chemical laboratory, to the factory, the boudoir, and the world, all under the gaze, nose, and hands of the man of science.

This rhetoric was achieved in practice by the conflation of household and scientific activities: mundane tasks and objects were identified with their more expert counterparts. These metonymic extensions from the candle to laws of nature arguably implied that the separation of the specialist laboratory, the factory, and the kitchen was a matter of quantity, not quality. Thus, this article can be read in the light of key debates over who could participate in the sciences in the second quarter of the nineteenth century. Symbolised in the artefact of the sliding scale, and underscoring contemporary rhetoric, were ideas of an egalitarian chemical community, in which all could contribute to ongoing research. In the 1820s, a correspondent wrote to *The Chemist* to applaud its aims of promoting a community in which all could participate with very little equipment: he outlined, in a reference to Wollaston, how "the profoundest of the English chemists discards the fopperies of apparatus, and keeps his laboratory within the compass of a tea-tray; a few glass tubes, a blowpipe, some twenty little phials, and three or four wine glasses, suffice for his experiments." The periodical also referenced Franklin, Priestley, and Watt to demonstrate how great discoveries could be made with mainly household objects.[80]

These familiar introductions to chemistry welcomed early Victorian children into a household and world in which even the commonest object was full of wonder. But more than this, they grounded chemistry in smelly, tasty and reassuringly tangible experiences: the perfumed whiff of an exotic origin, the taste of a sugary solution, the heat of a candle flame, the weight of everyday commodities as they rested in the hand. New ideas were impressed on the mind through those "gateways of knowledge," the senses: thus, these lessons on the science of common things were not just designed to get children to think about things in new ways: they were supposed to perceive, taste, touch and smell differently, too. Whether with a dedicated "Youth's Laboratory," a few cheap gas jars, or simply a candle or a bar of soap, the sensory practices of familiar chemistry was used to make sense of the surrounding scientific world, and also to make senses in those who engaged in it. I hope to have demonstrated some of the ways in which the mid-nineteenth century witnessed a particularly significant conjunction of the family location, lessons on familiar objects and the omnipresence of familiar introductions to varied topics, which made "familiar chemistry" such a crucial education style. By the end of the century, popular science coalesced into a thriving existence; national systems of education were in place in which scientific subjects were gaining greater representation; and elementary works were no longer described "familiarly explained." Arguably these were some ways in which familiar chemistry lost its particular potency. However, this was of course not the end of the tendency to exploit everyday activities

[80] Jan Golinski, *Science as Public Culture* (Cambridge: Cambridge University Press, 1992), 263.

for educational ends. From sugary solutions to bicarb and vinegar volcanoes, kitchen chemistry will continue to find new forms in the twenty-first century and beyond.[81]

Notes on contributor

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[81] For instance, http://science-at-home.org/volcanoes/ (accessed 8/11/12).